VibroSmart® distributed monitoring system

VibroSmart distributed monitoring for industrial turbines, critical machinery and balance-of-plant equipment enables you to monitor more of your assets, across more plants and more cost-effectively—with no compromise on performance.

Critical and non-critical rotating assets

- hydroelectric turbines
- gas turbines
- steam turbines
- wind turbines
- motors
- centrifugal compressors
- reciprocating compressors
- steel and paper rollers
- generators
- pumps
- cooling towers and heat exchanger fans
- heat exchangers
- balance-of-plant equipment
- blowers
- gearboxes
- turbo-expanders
- reciprocating pumps

Industries

- power generation
- oil and gas
- hydro power
- steel production
- biomass
- pulp and paper
- water and wastewater
- horizontal fracking
- pharmaceutical
- process monitoring
- mining and aggregates
- marine and shipping
The VibroSmart family of products
The VibroSmart product family is designed for machine monitoring in an independent or distributed operating mode while potentially located in harsh industrial environments including ATEX Zone II (Class I Div 2) hazardous areas and temperatures up to 70°C. VibroSmart complements the VM600 series of rack-based solutions from our Vibro-Meter® product line and interfaces with the same VibroSight® software to provide a total monitoring solution.

VibroSight - orbit plot example
Each stand-alone VibroSmart module features two dynamic inputs and one auxiliary input configurable as a tachometer or a static input. A single module can offer both machinery protection and advanced signal processing capabilities for condition monitoring and provides the tools for events diagnostics. Multiple VibroSmart modules can be linked together to form a measurement block communicating via a real-time Ethernet-based interface.

Designed to make the activities of operators, maintenance personnel and engineers intuitive, the implementation of a VibroSmart distributed monitoring system (DMS) is rapid and easy.
A VibroSmart DMS performs the monitoring and protection functions required by critical assets, even directly on a machine skid, leveraging embedded chipsets to execute complex algorithms for advanced signal processing and noise reduction.

A response to industry demands
Where more compact engines and machines are demanded, there is a general industry trend towards locating monitoring equipment close to the machine being monitored to minimize or eliminate expenses associated with control rooms, electrical cabinets and long cable runs. Rugged design and hazardous area certifications enable VibroSmart to be DIN-rail mounted on a skid near the machine to reduce the cost and complexity of the overall installation.

Modular and scalable
VibroSmart’s truly modular and scalable nature responds to a wide range of industry demands:
Thanks to its 2 to 256 dynamic channels per system, VibroSmart DMS covers the protection and condition monitoring needs of most applications. During the life of an installation, an increase in channel count can easily be accommodated by adding one or more additional modules to the measurement block. These modules can simply be integrated into the existing DMS communication network. The installation and configuration effort is reduced to a minimum.
The VibroSmart input channels are extensively configurable via software to host all common measurement types. This modularity enables to build a full protection and condition monitoring system based on a single type of module and thus reducing the maintenance effort and the number of spare parts.
A single VibroSmart module can act as a complete stand-alone monitoring system. Multiple VibroSmart modules can be mounted adjacently or interconnected using standard Cat 6 Ethernet cables, to form a measurement block with higher channel count. Multiple measurement blocks can be networked to the same VibroSight server, to easily create a complete DMS with all of the functionalities required by any machinery monitoring application.
A measurement block is a functional grouping of multiple VibroSmart modules. Measurement blocks enable inter-module communication, including sharing of tachometers, alarms and several event/trigger messages. They also allow the alarm and status information to be logically combined in order to drive relays or fieldbus outputs.

Example of a VibroSmart DMS measurement block

VibroSmart® system overview
Version 5, 16.10.2014
System communications

VibroSmart utilizes state-of-the-art communication technologies to link its distributed elements and enable the integration of a VibroSmart DMS into process controls and plant network.

- Real-time Ethernet (100 Mbit/s) is used for module-to-module communication, within a measurement block.
- Ethernet (100 Mbit/s) is used for module-to-host computer (VibroSight) communication.
- The VSI010 module allows interfacing, through Industry standard fieldbuses such as PROFIBUS and Modbus, with process control systems (PLC, DCS, SCADA, etc).
- PROFIsafe (over PROFIBUS DP) safety communication technology is used to ensure that critical safety-related communications are delivered intact, to the right destination and on-time.

Integration

VibroSmart’s modular architecture and fieldbus capabilities reduce the time and effort required to integrate a DMS with a third-party control system.

Networking

The discovery mechanism used on a VibroSmart DMS network can be summarized as “zero configuration networking” or simply zeroconf. Zeroconf allows non-specialist users to connect computers and other network devices and automatically establishes a functioning network. The VibroSmart modules accept both the static and the automatic IP addressing modes, (with or without DHCP server).

Synchronisation

While a VibroSmart DMS used for machinery protection only does not require time synchronization, condition monitoring applications usually require synchronisation between the VibroSmart modules and the host computer running the VibroSight software, so that data can be correlated using a unique time reference. The VibroSmart DMS can use two types of time reference:

- Local clock of the host PC running VibroSight Server
- Network time protocol (NTP) server

System availability

The VibroSmart modules implement a number of important features in order to allow uninterrupted availability:

- Redundant power supply inputs
- Redundant real-time Ethernet
- Runtime built-in test (BIT) and diagnostics
- Live insertion and removal of modules (hot-swappable) with auto-detection and auto-configuration.

Hot swapping

Upon removal of one VibroSmart module, communication continues between the remaining modules. When a VibroSmart module is replaced, it is automatically configured from settings saved in the terminal base.

Environment

The VibroSmart modules were designed to operate in harsh industrial environments. Modules are rated to operate at temperatures up to 70°C, acceleration up to 2 g (any axis) and shocks up to 15 g.

The VibroSmart modules are currently undergoing certification and will be available in Ex-approved versions for use in hazardous areas.

Europe: Ex nA (“non sparking apparatus”) for ATEX Zone 2
North America: Class I, Division 2

Coming soon

In 2015, Meggitt Sensing Systems will release a family of signal conditioners that plug into the VibroSmart terminal base and interface with most standard industry sensors, such as eddy current probes, accelerometers and dynamic pressure sensors.

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VibroSmart® system overview
Version 5, 16.10.2014
Total monitoring solution

The VibroSmart DMS is designed to operate in conjunction with Meggitt’s VibroSight total monitoring solution software.

VibroSight is a highly integrated software suite that supports the effective condition monitoring of all rotating machinery.

Designed for operation with the VM600 XMx16 cards and/or the VibroSmart DMS, the VibroSight software forms part of a modular monitoring system that enables predictive methodologies which can be used to help improve the effectiveness of industrial machinery. In particular, a VibroSight-based monitoring system can be used to:

- Minimize downtime through the planning and scheduling of maintenance activities
- Maximize component life by avoiding known critical operating conditions
- Improve equipment reliability through the effective prediction of equipment failures
- Use condition monitoring techniques to maximize equipment performance

When used by technicians, operators and engineers, VibroSight enables them to identify a problem rapidly, evaluate the situation and determine the appropriate action to take.

Several VibroSight software editions are available to accommodate a multitude of application requirements, ranging from stand-alone machinery protection including alarms, event lists and live data display to full condition monitoring solutions with data recording for in-depth analysis in both the time and the frequency domain.

The following types of plot are included as standard in the VibroSight catalogue of plots:

- Static plots: Bar Chart, Bode, Correlation, Polar, Shaft Centerline, Table, Trend
- Dynamic plots: Orbit, Spectrogram, Spectrum, Full Spectrum, Waterfall/Cascade, Full Waterfall/
  Cascade, Waveform

VibroSight plots including: Amplitude trend, Tacho speed, Power and waterfall/Cascade

VibroSight spectrum and waveform plots
## Product features

<table>
<thead>
<tr>
<th>Module Description</th>
<th>Main features</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSV300 vibration monitoring module</td>
<td>• 2 individually configurable dynamic input channels with up to 19 kHz bandwidth for</td>
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<tr>
<td></td>
<td>› accelerometers, velocity and proximity probes</td>
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<tr>
<td></td>
<td>› dynamic pressure sensors</td>
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<td></td>
<td>› process sensors (current loop or voltage based)</td>
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<tr>
<td></td>
<td>• 1 auxiliary input channel for tachometer or quasi-static measurements</td>
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<tr>
<td></td>
<td>• synchronous sampling of input channels</td>
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<tr>
<td></td>
<td>• synchronization accuracy (with modules of the same measurement block) better than 1 µs</td>
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<tr>
<td></td>
<td>• waveform and full spectrum up to 1600 line FFT every second</td>
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<td></td>
<td>• up to 20 processed outputs per module, for following processings:</td>
</tr>
<tr>
<td></td>
<td>› broad-band absolute vibration</td>
</tr>
<tr>
<td></td>
<td>› narrow band vibration (order tracked)</td>
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<tr>
<td></td>
<td>› shaft relative vibration</td>
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<tr>
<td></td>
<td>› broad-band pressure/pulsation (combustion)</td>
</tr>
<tr>
<td></td>
<td>› position</td>
</tr>
<tr>
<td></td>
<td>› Smax (dual)</td>
</tr>
<tr>
<td></td>
<td>› X-Y max discriminator (dual)</td>
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<tr>
<td></td>
<td>› orbit (dual)</td>
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<tr>
<td></td>
<td><strong>coming soon</strong></td>
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<tr>
<td></td>
<td>› eccentricity</td>
</tr>
<tr>
<td></td>
<td>› absolute shaft vibration (dual)</td>
</tr>
<tr>
<td></td>
<td>› quasi-static DC processing</td>
</tr>
<tr>
<td></td>
<td>• 4 alarms per processed output, each configurable with hysteresis and time delay</td>
</tr>
<tr>
<td></td>
<td>• AND, OR and majority voting logic functions for the combination of alarm and status information, including 4 basic and 2 advanced logical functions</td>
</tr>
<tr>
<td></td>
<td>• 4 discrete signal inputs</td>
</tr>
<tr>
<td></td>
<td>› trip multiply, alarm bypass, alarm reset and 1 spare</td>
</tr>
<tr>
<td></td>
<td>• 2 local analogue outputs, configurable either as 4-20 mA current loop (DC) or ±5V processed AC outputs</td>
</tr>
<tr>
<td></td>
<td>• 2 local SPDT relay outputs</td>
</tr>
<tr>
<td></td>
<td>• operating ambient temperature -20 to 70°C [4 to 158°F]</td>
</tr>
<tr>
<td></td>
<td>• the VSV300 module must be mounted on a VSB300 terminal base</td>
</tr>
<tr>
<td>Module Description</td>
<td>Main features</td>
</tr>
<tr>
<td>--------------------</td>
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</tbody>
</table>
| **VSI010 communication interface module** | • capture of selected real-time data within a measurement block (max 16 modules) and output to fieldbuses  
• synchronization accuracy (with modules of the same measurement block) better than 1 µs  
• 2 independent serial fieldbuses (RS-485) capable of operating simultaneously  
• 1 Ethernet based fieldbus with up to two IEEE 802.3u ports  
• supported fieldbus protocols:  > Modbus RTU  > PROFIBUS DPV0 and DPV1  > PROFlsafe over PROFIBUS  
 | coming soon  > Modbus TCP, PROFINET IRT  
• AND, OR and majority voting logic functions for the combination of alarm and status information, including 8 basic and 4 advanced logical functions  
• 4 discrete signal inputs  > trip multiply, alarm bypass, alarm reset and fieldbus communication stop  
• 2 local SPDT relay outputs  
• operating ambient temperature -20 to 70°C (-4 to 158°F)  
• the VSI010 module must be mounted on a VSB010 terminal base |

| VSB300 and VSB010 terminal bases |  
| Provides mounting and physical paths (SBUS) for the transmission of data and redundant power.  
Guarantees the transmission of real-time critical data, inter-module synchronization and synchronization with a host computer and/or external systems.  
• Mounts on a TH 35-7.5 DIN rail  
• Holds the configuration of a VibroSmart module  
• 2 redundant power supply inputs  
• Locking mechanisms  
• Mechanical key-coding  
• Sharing of real-time critical information between modules via SBUS: triggers, alarms, time stamps  
• operating temperature -20 to 70°C (-4 to 158°F)  
• VSB300 terminal base is compatible with the VSV300 module  
• VSB010 terminal base is compatible with the VSI010 module |
**VibroSmart® system overview**

**Version 5, 16.10.2014**

### Module Description

**VSN010 real-time Ethernet switch**

High-availability seamless redundancy with no single point of failure and zero recovery time. Fault-tolerant protocol enables cost-effective real-time redundant ring of VibroSmart modules. CE approved. ATEX Ex nA IIC T6 Gc certification for use in hazardous environments. Ongoing cCSAus/CSA certification.

<table>
<thead>
<tr>
<th>Main features</th>
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</thead>
<tbody>
<tr>
<td>• High-availability seamless redundancy with zero recovery time (HSR, IEC 62439-3)</td>
</tr>
<tr>
<td>• Rapid spanning tree protocol (RSTP, IEEE 802.1D)</td>
</tr>
<tr>
<td>• 2 redundant power supply inputs</td>
</tr>
<tr>
<td>• DIN rail (TH 35-7.5) or rack mount</td>
</tr>
<tr>
<td>• 3 ports, RJ-45 sockets with 100 Mbit/s Ethernet (IEEE 802.3)</td>
</tr>
<tr>
<td>• Operating ambient temperature -20 to 70°C (-4 to 158°F)</td>
</tr>
<tr>
<td>• No configuration required</td>
</tr>
</tbody>
</table>

**VSA004 and VSA005 BNC patch panels**

Robust aluminium patch panels that simplify installation and wiring of a VibroSmart DMS when sharing of VSV300 buffered transducer (“raw”) signals via front-panel BNC connectors are required.

<table>
<thead>
<tr>
<th>Two versions of BNC patch panel are available:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• VSA004 DIN rail mounting patch panel with 10 slots</td>
</tr>
<tr>
<td>• VSA005 19” rack mounting patch panel with 21 slots</td>
</tr>
<tr>
<td>Individual patch panel slots can be populated with either a blank panel or a panel providing three BNC connectors corresponding to a VSV300’s input channels (two dynamic channels and one auxiliary channel).</td>
</tr>
<tr>
<td>Each populated patch panel slot includes a 2 metre cable assembly to connect to a VSV300 module</td>
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</tbody>
</table>
Example 1

Example of one VibroSmart VSV300 module configured for stand-alone operation (without VibroSight server). Suitable for machinery protection applications.

Example 2

Example of a VibroSmart DMS with 3 measurements blocks including industry standard fieldbus interfaces and a VibroSight server with 2 client computers. Suitable for applications requiring machinery protection and condition monitoring.

Measurement block #1 is a redundant network (HSR ring) with redundant power supplies.
Measurement block #2 provides no redundancy.
Measurement block #3 is a redundant network (HSR ring) of modules located in 2 different locations, having each redundant power supplies.
Example 3

Example of a VibroSmart measurement block for a gas turbine, configured with redundant network (HSR ring) and redundant power supplies

Monitoring points

A represents an accelerometer, mounted in the x or y axis

P represents a proximity probe, mounted in the x or y axis

C represents a dynamic pressure sensor, mounted in a combustor

Processing

In this example, VSV300 modules monitor absolute vibration and relative shaft vibration at each bearing and shaft of the gas turbine. Combustor dynamic pressure is also monitored.

Two power supplies provide redundant power to all VibroSmart modules.

Using a VSN010 real-time Ethernet switch, this VibroSmart DMS offers high-availability seamless redundancy (HSR) with no single point of failure and connects to the VibroSight software for trending and analysis.

The VSI010 communication interface connects this measurement block to the plant’s control system (PLC, DCS, SCADA, etc) and to relays for shutdown capability.
Headquartered in the UK, Meggitt PLC is a global engineering group specialising in extreme environment components and smart sub-systems for aerospace, defence and energy markets.

Meggitt Sensing Systems is the operating division of Meggitt specialising in sensing and monitoring systems, which has operated through its antecedents since 1927 under the names of ECET, Endevco, Ferroperm Piezoceramics, Lodge Ignition, Sensorex, Vibro-Meter and Wilcoxon Research. Today, these operations are integrated under one strategic business unit called Meggitt Sensing Systems, headquartered in Switzerland and providing complete systems, using these renowned brands, from a single supply base.

The Meggitt Sensing Systems facility in Fribourg, Switzerland, was formerly known as Vibro-Meter SA, but is now Meggitt SA. This site produces a wide range of vibration and dynamic pressure sensors capable of operation in extreme environments, leading-edge microwave sensors, electronic monitoring systems and innovative software for aerospace and land-based turbomachinery.

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In this publication, a dot (.) is used as the decimal separator and thousands are separated by thin spaces. Example: 12 345.678 90.